

Final Exam: Introductory Immunology MICR422, December 13, 2001.

You have 100 minutes to complete this test. Except where specified, you should answer in complete sentences and/or essay format. Diagrams are acceptable additions to essays, however are NOT a substitute for a coherent, written answer. Try and keep your answers confined to the space provided, but you may use the back of the page if necessary. The TOTAL marks for each question, 1-10, are shown in the margins. The total for this exam is 80 points.

- 1. Identify the following organs as primary (P) or secondary (S) lymphoid organs.**

5 marks

- a. S Peyer's patch
b. S Spleen
c. P Bone Marrow
d. P Thymus
e. S Lymph Node

- 2. Identify the cell type (from the list below) with the surface antigen. Each antigen may be used only once.**

5 marks

Cell Type: CD4, CD8, CD19, CD14, B7

- a. B7 Dendritic Cells
b. CD19 B cells
c. CD4 T-helper 2 cells (TH2 cells)
d. CD8 Cytotoxic T cells
e. CD14 Resting Macrophages

3. Match each of the following descriptions with the most appropriate immunoglobulin isotype, IgM, IgG, IgA, IgE, IgD

5 marks

- a. IgA Primary isotype involved in mucosal immunity
- b. IgE Primary isotype associated with immunity to parasites
- c. IgD Found primarily on the surface of naïve B cells but not in serum.
- d. IgG Most abundant isotype in normal sera.
- e. IgM Most effective at producing immune complexes in vivo.

4. Identify the following statements as applying to the development of T_H1 or T_H2 type responses.

5 marks

- a. T_H2 Primarily associated with immunity to extracellular antigens
- b. T_H2 Stimulates eosinophil activation and differentiation.
- c. T_H1 Differentiation stimulated by local presence of Interleukin-12
- d. T_H1 Differentiation inhibited by Interleukin-10
- e. T_H1 Provides help to CTL activation.

5 marks

5. You are provided with a 50 ml blood sample from an HIV-positive patient and asked to assess the relative proportions of CD4 and CD8 positive lymphocytes. In order to stain the cells with appropriate antibodies, you need to add 5×10^6 cells (in a total volume of 50 μ l) to each tube of antibody (CD4, CD8, PBS). Following lysis of the red blood cells and several washes, you resuspend in 5 ml for counting. Since there are too many cells in 1 large square, you count 3 small squares and get the following cell numbers (38, 35, 47) in each of the 3 small squares. (triple-ruled).

- i. How many cells have you got in the tube?
- ii. What was the original cell concentration in the blood sample?
What is the normal range (within a factor of 10) for leukocyte counts in blood - is the patient lymphopenic, or do they have normal numbers of leukocytes in the blood?
- iii. What is the required cell concentration that you will need to stain your cells?
- iv. After centrifuging the cells, what volume (in ml) of PBS should you add to your sample to have the required concentration of cells for staining?

- i. 1×10^7 /ml, 5×10^7 in the tube
- ii. 1×10^6 - At the very low end of the normal range
- iii. 1×10^8 cells/ml
- iv. 0.5 ml, or 500 μ l

6. Match each term related to innate immunity with the most appropriate description listed below (1-7). Each description may be listed once, or not at all.

5 marks

a. 4 Lysosome

b. 1 Bradykinin

c. 6 Lysozyme

d. 2 Interferon

e. 5 Histamine

1. Stimulates pain receptors in the skin
2. Has antiviral activity
3. One of several acute-phase proteins
4. Cytoplasmic vesicle containing degradative enzymes
5. Induces vasodilation
6. Hydrolytic enzyme found in mucous secretions.
7. Group of serum proteins involved in cell lysis and clearance of antigen.

7. For each type of cell listed below, select the most appropriate description (1-8) listed below. Each description may be used once or not at all.

5 marks

a. 1 Veiled Cells

b. 3 Bone Marrow Stromal Cells

c. 5 Eosinophils

d. 4 Natural Killer Cells

e. 7 Langerhans Cells.

1. Dendritic cells found in afferent lymph and lymph nodes.
2. Generally first cells to arrive at site of inflammation.
3. Secrete Colony-Stimulating Factors (CSFs)
4. A type of null cell involved in antibody-dependent cell-mediated cytotoxicity.
5. White blood cells that migrate into the tissues and play an important role in the development of allergies.
6. Give rise to red blood cells

- 7. Dendritic cells found in the skin and mucous membranes.
- 8. CD8+ cells that may be important in combating intestinal pathogens.

5 marks

8. Define or state the significance of each of the following terms:

Natural/Innate Immunity: Non-specific barriers and cells which protect against disease. Does not demonstrate the characteristics of specificity or memory.

Attenuated Vaccine: A vaccine using a live virus or bacteria which has been rendered non-virulent, resulting in a strong immune response.

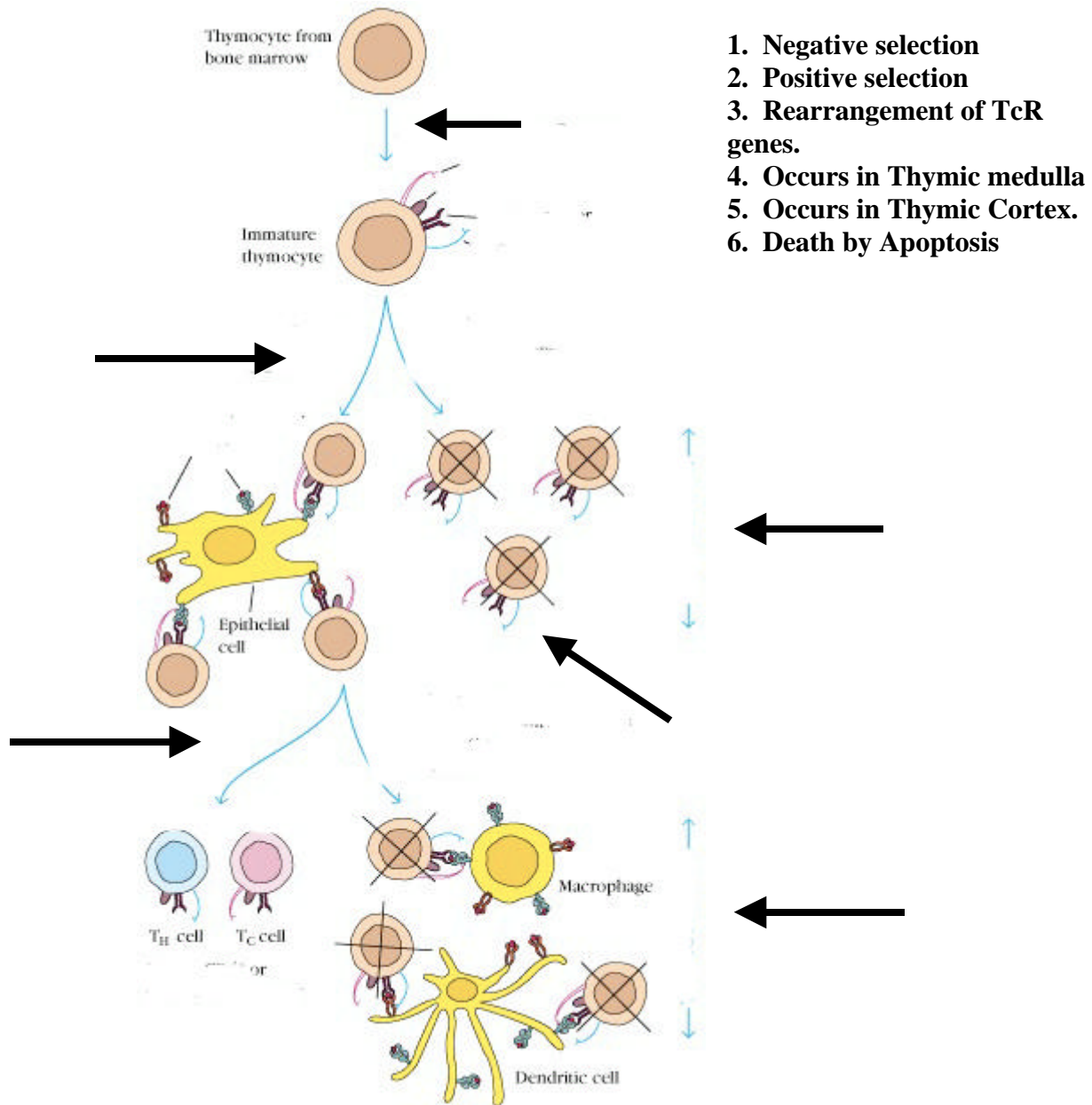
RAG-1 One of several proteins involved in recombination of immunoglobulin or T cell receptor genes, recognizing specific recombination-signal sequences within the genes.

Adjuvant: A substance which will non-specifically upregulate the immune response to an immunogen/vaccine, may act to induce inflammation or perform as an antigen depot

ELISPOT Assay: An assay, similar in design to the ELISA, used to detect the frequency of cells in a population which secrete a specific antibody or cytokine.

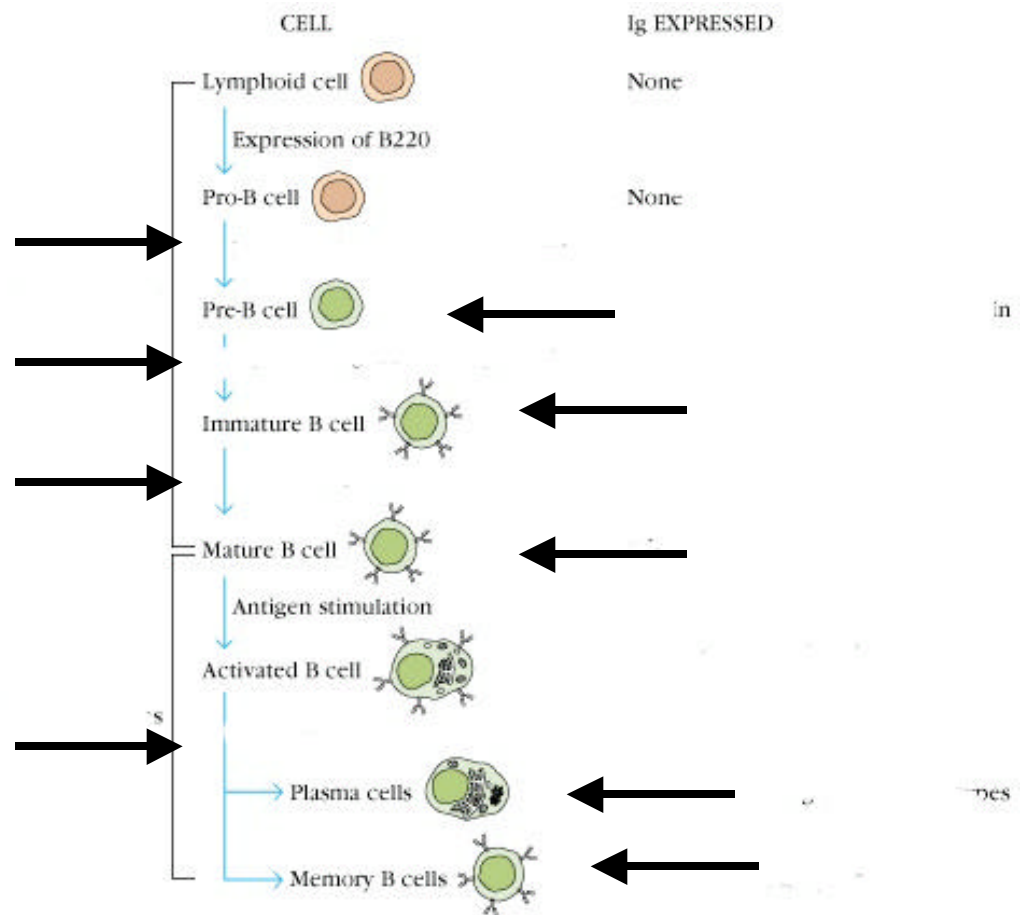
9. Choose 1 of the following 2 questions (i or ii), and label the diagram appropriately with the appropriate words or phrases. Answer the additional questions in 1 or 2 sentences maximum on the next page.

- i. Describe thymic development/education of T cells, from the arrival of newly-formed pre-T cells to the release of fully functional, mature T cells.
 - a. Describe positive and negative selection in terms of affinity for self-MHC.
 - b. What factor selects for CD4 or CD8 expression on the surface of mature T cells?
 - c. Label the following stages (put a number next to the arrows):



Name: _____

OR (see next page)



ii. For the above diagram depicting B cell development, indicate (by placing an appropriate number next to the correct arrow) where each of the following statements applies.

1. Class switching and affinity maturation.
2. Change in RNA processing to simultaneously express membrane IgM and IgD.
3. Light chain gene rearrangement.
4. Heavy-chain gene rearrangement.
5. Expression of μ heavy chain and surrogate light chain.
6. Expression of membrane IgM only.
7. Secretion of Ig of various isotypes.
8. Expresses membrane Ig of various isotypes, including IgG, IgA, IgE.
9. Expression of IgM and IgD.
10. Draw an arrow to identify at which stage B cells leave the bone marrow and enter the periphery.

30 marks

10. Choose 2 of the following questions, and answer in essay format. Each question is worth 15 points. Diagrams may be used to compliment a written answer, but will not be taken as a substitute for a well-written response.

- A. Compare and contrast the 4 types of hypersensitivity reactions according to the following criteria:**
- i. Which immunological component/function mediates each type (i.e. Ig isotype, Cell-mediated hypersensitivity, major cell types involved in the response.)**
 - ii. What are the immunological mechanisms which cause damage to the local or systemic tissues in each case?**
 - iii. What are the typical manifestations/symptoms of each type of hypersensitivity?**

AND/OR

- B. Discuss and contrast the mechanisms of T and B cell receptor development according to the following criteria.**
- i. Discuss the order of rearrangement of heavy and light chains, using appropriate terminology for the TcR genes.**
 - ii. Describe any differences in the rearrangement of V-D-J or V-J segments between B and T cells.**
 - iii. Name the relevant proteins and describe the use of surrogate light chain to regulate rearrangement of the genes.**
 - iv. Describe any differences in the use of positive and negative selection between B and T cells.**
 - v. Identify the major difference(s) between B and T cell antigen receptor diversification following antigen stimulation.**

AND/OR

- C. Some types of allergy develop due to the inappropriate production of IgE antibody in response to a normal, environmental allergen. The majority of these allergens are initially inhaled, and exposure occurs within the respiratory immune system (BALT). Describe the events that occur following the first time inhalation of ragweed pollen that would result in an allergic response according to the following criteria.**
- i. Nature of the original antigen presenting cell.**
 - ii. Relevant cellular interactions resulting in activation of B and T cells within the regional lymph node**
 - iii. The type of T-helper response that must be generated to result in allergy**
 - iv. Relevant cytokines that would result in the production of IgE by B cells**
 - v. A brief summary of how allergy symptoms are induced on secondary exposure to ragweed pollen.**

AND/OR

- D. Although it remains unclear, one theory of why adjuvants upregulate the immune response is their ability to stimulate non-specific inflammation. Describe the chemical and cellular processes generated by subcutaneous injection of Freund's Complete Adjuvant, with reference to the following points.**
- i. Name the 2 major components of Freund's Complete Adjuvant.**
 - ii. Describe the 5 cardinal signs of inflammation, and how FCA could be expected to induce these symptoms.**

AND/OR

- E. It is believed that there are at least 3 distinct “pools” of T lymphocytes which recirculate preferentially through 3 lymph nodes, skin, or gut epithelium. Discuss tissue-specific recirculation, including the following points in your answer:**
- i. Differential migration pathways of naïve and memory lymphocytes**
 - ii. Identify endothelial molecules (vascular addressins) which specifically direct the migration of each of these populations through distinct tissues in vivo.**
 - iii. Identify cell-surface molecules expressed on the surface of lymphocytes which direct this tissue-specific homing.**
 - iv. How does this differential migration contribute to the efficient development of a primary or secondary immune response and the dissemination of effector or memory cells?**

Name: _____

Name: _____

Name: _____

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